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Løje, H.; Grex, S.

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How to foster entrepreneurial mind-set in a compulsory course with many students?

H. Løje¹

Senior Innovation Officer
Technical University of Denmark
Ballerup, Denmark
halo@dtu.dk

S. Grex

Associate Professor
Technical University of Denmark
Ballerup, Denmark
sarg@dtu.dk

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INTRODUCTION

A clear trend in today's society and work life is a growing need for skills in interdisciplinary collaboration and innovation. Industry requires engineers with good communication and teamwork skills and a broader understanding of how to solve real-world problems and create value in the marketplace by competing on innovation [1]. Therefore, many universities are developing educational programs to foster competences within innovation and entrepreneurship and these educational programs have grown in pace and scale worldwide also in engineering education, with the aim to develop engineers who have entrepreneurial ways of thinking and working, which they can apply within existing organizations of different sizes and types [1].

Entrepreneurship education is about developing attributes and competences in students, developing personal attributes and skills that form the basis of an entrepreneurial mind-set and behaviour including creativity, initiative, risk-taking, autonomy, self-confidence,

¹ H. Løje
halo@dtu.dk

leadership, realisation of values and team spirit [2]. It is also about raising awareness amongst students of self-employment and new venturing as possible career choices.

In terms of learning style, the development of an entrepreneurial mindset, calls for use of pedagogical tools like problem solving, problem-based learning and active engagement of the students [1], [2]

Another trend to take in to consideration is the growing class size at many universities and the need to rethink the teaching style and learning design by supporting authentic and self-directed learning on courses with many students. With larger classes and especially with compulsory courses, the student group often becomes more diverse regarding motivation, commitment, professional prerequisites and experience with project work and working with open challenges.

In this study, we explore how a framework for a course in innovation and entrepreneurship can be designed when aiming at a course set up for large classes that can both inspire and motivate the students and foster an entrepreneurial mind-set.

1 TRAINING BACHELOR OF ENGINEERING IN INNOVATION AND MULTI-DISCIPLINARY TEAM WORK

Innovation Pilot is a multi-disciplinary course (10 ECTS point) on innovation and entrepreneurship for 3rd year students in the bachelor of engineering program at The Technical University of Denmark (DTU). The course is compulsory for all students in the named programmes. Approximately 350 students from 17 study programmes attend the course during each spring and winter semester and approximately 100 students attend the summer course. At the beginning of the course, the students are grouped into multidisciplinary groups of 5-6 students with maximum two students from the same study line.

Innovation Pilot is a practice-oriented course with the overall aim to promote an innovative mind-set and enable students to participate in innovation processes as well as to organize and implement a multi-disciplinary innovation process using relevant innovation models and methods. The students work in multidisciplinary teams with specific real-life challenges offered by the involved companies. The companies provide open-ended projects, which take a starting point in actual challenges observed by the company. The company is the problem owner and the students should involve the context reality of the company in solving the challenges. The students are responsible for finding ways to apply their professional skills and knowledge to create value in the projects.

1.1 Course design and learning processes

The overall course design aims at challenging the students and bringing them out of their regular comfort zone. To structure and support the student's innovation process the Double Diamond model created by [3] is used. The model presents four main stages across two adjacent diamonds, where the first diamond concerns exploring and understanding of the problem and the second diamond concerns problem-solving. The model is building on the four phases 1) Discover (divergent phase), 2) Define (convergent phase), 3) develop

(divergent phase) and 4) deliver (convergent phase), where the divergent and the convergent phases comprising of explorative and synthesis works, respectively. In addition, a set of supporting innovation models and tools to be used in the different phases of the double diamond process is available to the students. The course introduces the model to the students in the very beginning of the course and it works as a guide for the students during the rest of the course. To gain reflective experience the course is designed in two learning loops where the students go through the “double diamond” process twice. Both loops involve real life company challenges.

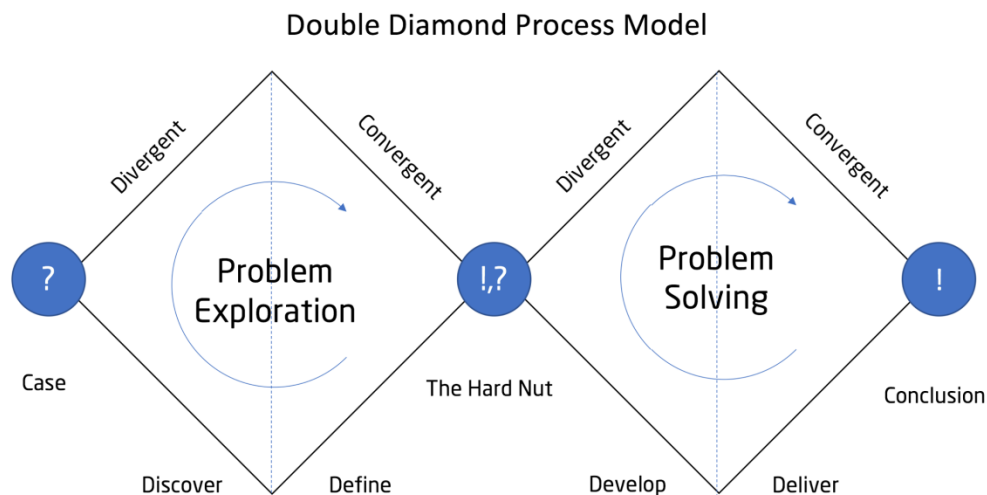


Fig. 1. Made by inspiration from the double diamond process model [3]

In both loops, the students conduct an innovation process structured according to the double diamond model (*Fig. 1*). The first loop takes four weeks and it is a training loop where the students get to know how to work with the double diamond process model with additional methods and tools. In the second loop, students work on a new challenge provided by a company and the process is structured as in the first loop, but now more independency and to be self-driven are expected from the student groups. The second loop takes 8 week with 3 weeks dedicated to exploring and defining the problem (the first diamond in Double Diamond) and 5 weeks dedicated to problem-solving and prototyping (the second diamond in Double Diamond). In each semester, about 20 companies are involved in the course.

The teaching styles is based on student centered learning where teaching methods such as active learning, teamwork, project based and real life problem solving are important “corner stones”. Furthermore, blended learning, peer-feedback and pitches are used as part of the teaching model.

At the end of the course, the students pitch their ideas and solutions at a big event involving both companies and innovation experts. For the evaluation, the students hand-in two group reports, one innovation report mainly targeting the company the group have worked with.

The other report is a reflection and learning report addressing the innovation process, team processes as well as learning outcome as both a group as well as individual. Each student receives an individual grade based on an overall evaluation of the two reports.

With this course design, we aim at adapting the qualities of learning processes in small class settings with dialogue and student-centered focus to a large class setting.

2 INVESTIGATING THE DEVELOPMENT OF ENTREPRENEURIAL MINDSET

One of the course aims is to enhance entrepreneurial and multidisciplinary competences of the students. The student's progression towards an entrepreneurial mind-set were evaluated using a questionnaire consisting of 28 statements and the students were asked their level of agreement.

2.1 Student survey

The survey "entrepreneurial mind-set self-assessment" [4] was used in the course to investigate how well the course meets its objective with respect to development of an entrepreneurial mind-set among the students. In the survey, the students rate themselves on 28 statements about topics central in an entrepreneurial mind-set. For all questions, the answers were given on a 5 point Likert scale where 1 indicates "strongly disagree" and 5 indicates "strongly agree". The survey was done once at the beginning of the course (pre-test) and again at the end of the course (post-test). Due to anonymity, it is not possible to pair the two tests.

3 RESULTS

3.1 Data from student survey

Data were collected in fall 2017 and spring 2018. Data consists of 210 and 141 respondents from the pre-test in fall 2017 and spring 2018, respectively and 67 and 135 respondents from the post-test in fall 2017 and spring 2018, respectively.

The questionnaire consists of 28 questions which are grouped into four topics concerning "Problem solving and critical thinking" (8 questions), "Teamwork" (7 questions), "Business acumen" (8 questions) and "Societal issues" (5 questions). The mean score for each question was calculated. In Figures 2-5, there is a visual presentation of the results for the four groups of questions. The left figure is data from fall 2017 and the right figure is data from spring 2018.

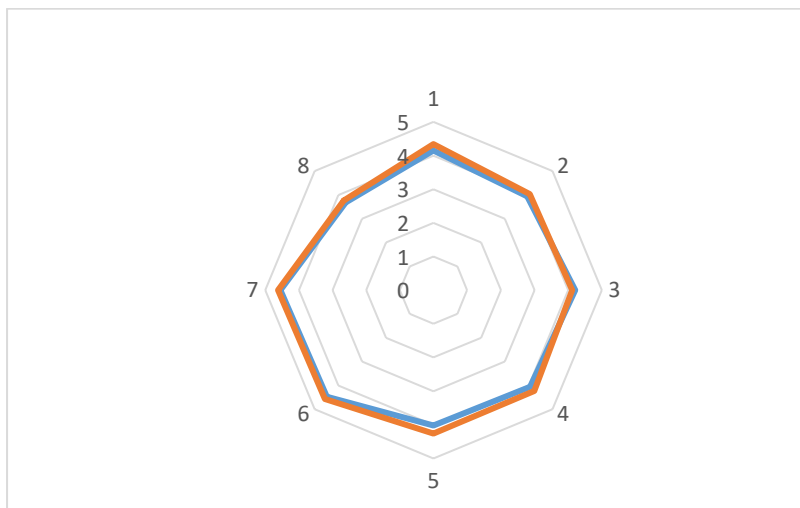
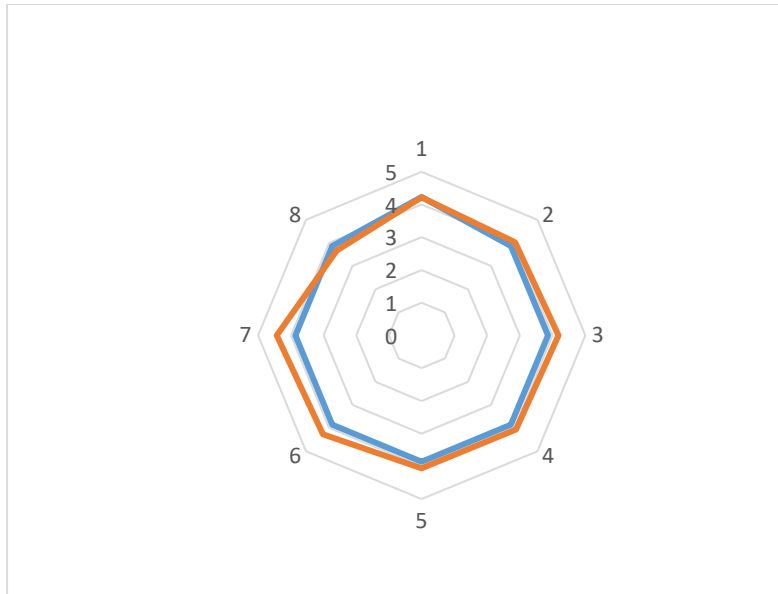


Fig. 2. **Problem solving and critical thinking** from fall 2017 (left side) and spring 2018 (right side). Pre-test = blue, Post-test = reddish , 1= "I am able to recognize problems that exist in the world around me", 2 = I am good at devising multiple solutions when solving problems", 3 = "I continue trying even after I have failed", 4 = "I ask relevant questions to clarify situations and gain new knowledge", 5 = "I am able to independently gain new information from various sources", 6 = "I accept responsibility for my personal actions", 7 = "I accept responsibility for the work I produce including mistakes", and 8 = "I think outside the box and am creative".

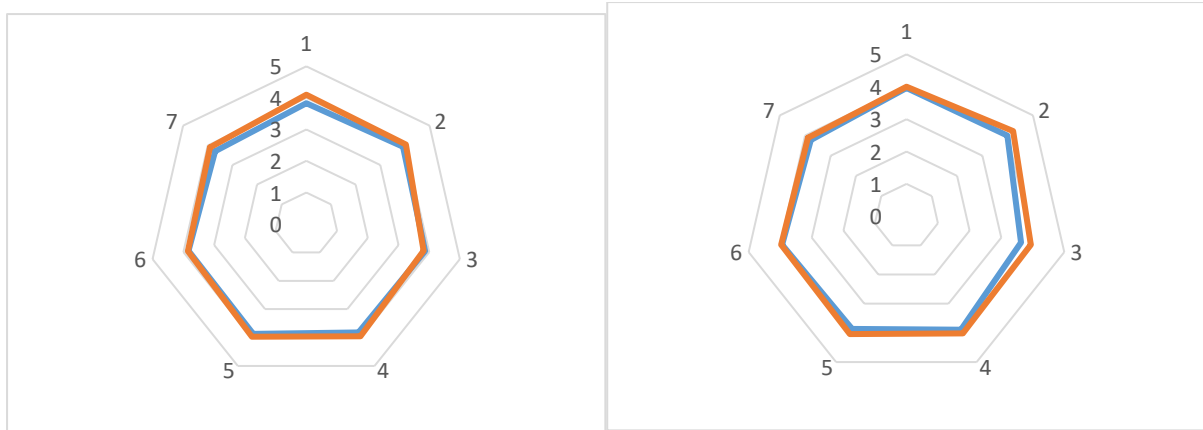


Fig.3. **Teamwork.** Data from fall 2017 (left side) and spring 2018 (right side). Pre-test = blue, Post-test = reddish, , 1 = “I understand and identify with the feelings, experiences and motives of others”, 2 = “I am aware of my personal strengths and weakness”, 3 = “I can identify strengths and weaknesses in others”, 4 = “I am able to determine whether I should lead or follow in different situations”, 5 = “I can develop and maintain working relationships with peers”, 6 = “I can develop and maintain working relationships with supervisors or superiors, and 7 = “I am capable of resolving conflicts”.

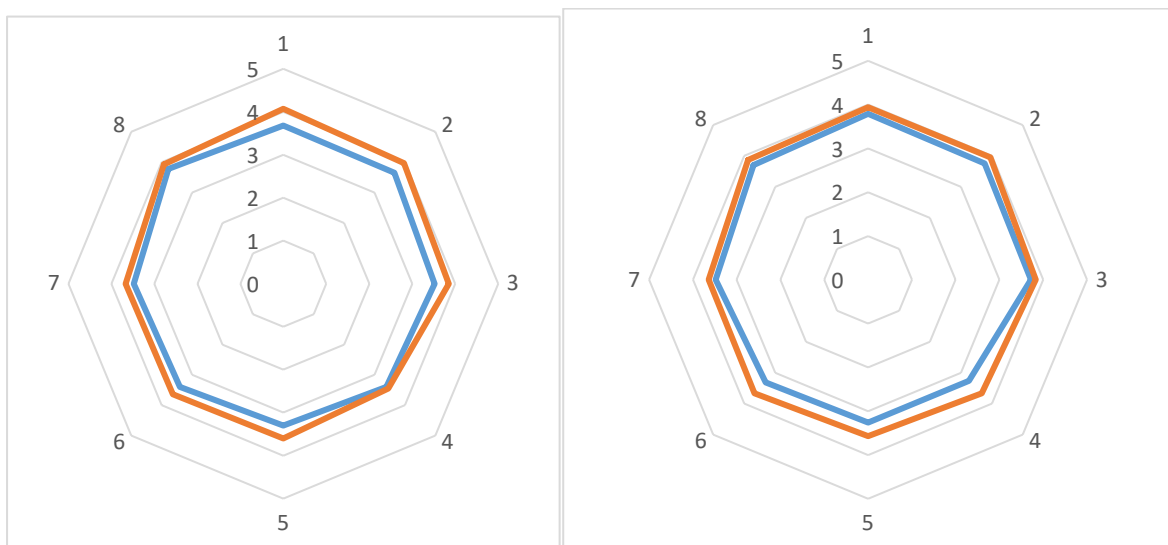


Fig. 4. **Business acumen** from fall 2017 and spring 2018 Pre-test = blue, Post-test = reddish. 1 = “I am able to verbally organize and communicate ideas appropriate to the situation”, 2 = “I am able to organize and communicate ideas in writing appropriate to the situation”, 3 = “I understand basic principles of business”, 4 = “I understand how marketing is used effectively within an organization”, 5 = “I understand the concepts of finance in a business setting”, 6 = “I access opportunity and recognize unmet needs”, 7 = “I access and undertake reasonable risks”, and 8 = “I can develop my own vision”.

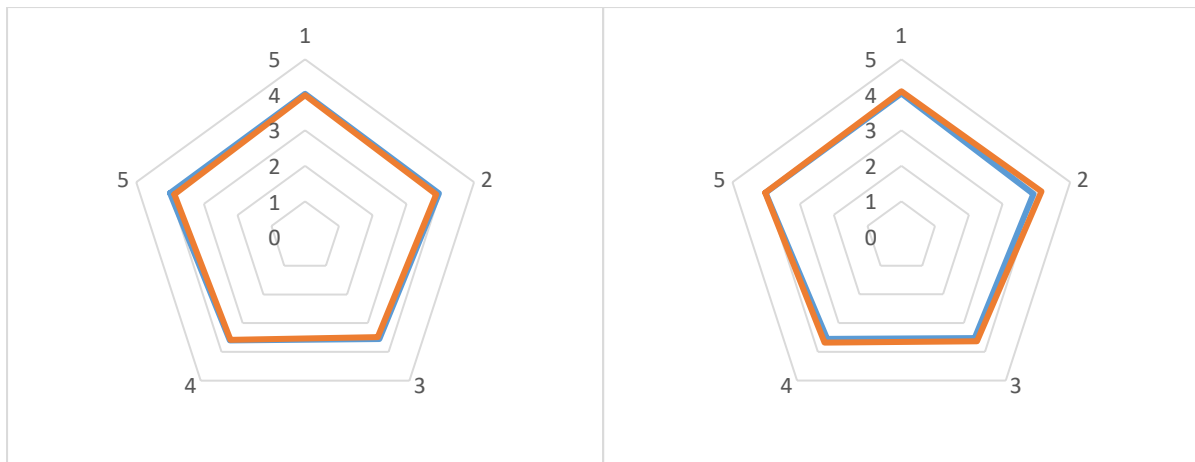


Figure 5. **Societal issues.** Fall 2017 and spring 2018. Pre-test = blue, Post-test = reddish. 1 = “I think and behave ethically”, 2 = “I am aware of how global issues influence society”, 3 = “I serve the needs of others”, 4 = “I try to make environmentally sensitive decisions” and 5 = “I aim to make a positive impact on society”.

3.2 Discussion

In general only small differences are observed between the pre-test and post-test for both data from 2017 and spring 2018. There is a tendency that the results from the post-test are slightly higher than seen for the pre-test. For the “Business cumen” there was a slight movement from the pre-test to the post-test. As part of the course curriculum, we provide the students with material about business issues. The course curriculum does not clearly relate to the other groups of questions.

Rootzen et al. [5] did the same survey with bachelor students from a course concerning “High-tech entrepreneurship”. They found that students move in a positive direction in all four groups of questions and they concluded that the students learn from the process in the course. But they saw the biggest difference in the students rating for “Societal issues” which is not clear in the present study. Rootzen et al [5] concluded that the students had seen the relevance in working multidisciplinary. This tendency is not clear in the present study.

4 DISCUSSION AND SUM UP

To sum up, in this paper we have described a framework for a course in innovation and entrepreneurship for large classes. We have looked into the impact of students entrepreneurial mindset using the “entrepreneurial mindset” questionnaire. However, the results from the questionnaire did not show any clear impact of the students entrepreneurial skills.

Compared with the students own learning and reflection reports (part of the evaluation) the survey results are to some extent surprising as the learning and reflection reports leave an impression of a higher learning outcome and more progression on the dimensions related to process understanding (problem solving/critical thinking and team work).

An explanation for this could be that the students lack a clear picture of what is learning and progression in this field and therefore have difficulties recognizing it. Further development

steps are therefore to include scaffolding elements [6], as a strategy to actively stage the content complexity of different teaching and learning activities in a way where student's learning abilities are met. This approach can also be used to promote and support the students taking a more active role for their own learning and sharing responsibility for learning with their fellow students. Attributes which are also central in developing an entrepreneurial mind-set.

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